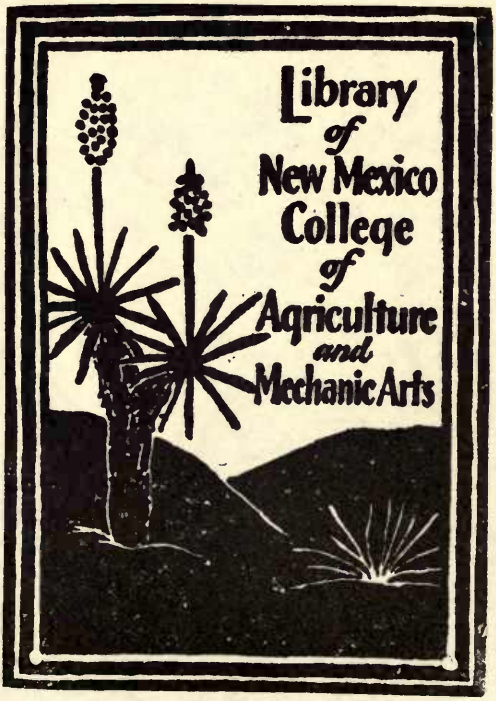

UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, NOVEMBER, 1890.

BULLETIN NO. 12.

FIELD EXPERIMENTS WITH OATS, 1890.

This article gives a record of experiments conducted during three years, in regard to the quantity of oats to sow per acre, the time and depth of sowing, and the manner of preparing the seed-bed; of experiments during two years in sowing oats and spring wheat together, and a test of a large number of varieties of oats.

It is the aim to report and interpret facts obtained; no prophecy is made with regard to the future. There are no means of determining absolutely that these results will be obtained again. Where, however, substantially the same results have been obtained during two or three years, the probabilities are that in this locality similar methods will in the future give similar results.

The largest yield of grain was produced from sowing two and one-half bushels of seed in 1888 and 1890, and from three and one-half in 1889. The average yield was slightly larger when three and one-half bushels of seed were sown per acre. Between two and one-half and three and one-half bushels of seed per acre there was but little difference, in yield, and with four bushels the yield was not much less.

In 1888 and 1889, a medium loose, and in 1890, a fairly compact seed-bed, gave the best results. A very compact and a very loose seed-bed have uniformly given the poorest results. The unplowed land gave this season better results than the plowed.

The time of sowing has had in these tests a more marked influence on the yield than any other condition. The earlier sowings, with one exception the earliest, have uniformly given the best yields. In these tests sowing prior to April 1st has given decidedly the best results.

The depth of sowing giving the best results has varied from one to four inches, and has not been the same in any two seasons.

No advantage has been found in sowing spring wheat with oats, either in the total quantity of grain produced or in the quality of the wheat. The percentage of wheat harvested was less than that sown.

In 1890, the so-called dun-colored rust-proof varieties, *Texas rust-proof, Texas red, and new red rust-proof*, yielded the best; in 1889, they were among the poorest. *Texas rust-proof* gave the largest yield this season and the smallest yield last season. *Giant yellow French*, which gave the largest yield in 1889, yielded indifferently in 1890. *Early Dakota white* is the only variety which did especially well both seasons.

There was an average of 66.2 per cent. of kernel in the berry of the seed, and 71.3 per cent. in the crop in 1890. The greatest difference of kernel in any two varieties was 15 per cent. in the seed sown, and 16 per cent. in the crop.

Those varieties which contained the higher per cent. of kernel in the seed sown contained the higher average per cent. of kernel in the crop, but did not yield quite so well as those containing a less per cent. of kernel in the crop.

The earlier ripening varieties yielded the most grain and the least straw and contained the least per cent. of kernel.

On the whole, the open panicled or branching varieties and the closed panicled side oats, have yielded equally well.

In 1890, the dun-colored varieties stood first in yield of grain, the black, second, and the white, third. In 1889 the white varieties stood first and the dun-colored, last. The dun-colored varieties have contained the largest per cent. of kernel.

The yield was not materially affected by the length, plumpness, or by the weight of the berry, or the weight per bushel. Those varieties with long, slender, light berries and light weight per bushel contained appreciably the larger per cent. of kernel. In other words, those varieties which would have sold best on the market, or, what is less important, would have taken the premium at the fairs, did not yield better than the other varieties and did not have so high a food value.

Experiment No. 12. Oats, Quantity of Seed per Acre.

Seven contiguous plats, each 2 x 4 rods, were sown broadcast with welcome oats at the rate of from 1 to 4 bushels per acre, April 5, 1888, March 27, 1889, and April 2, 1890. The first two seasons the oats were sown on fall-plowed land and covered with a disk harrow and twice harrowing. The last season a different tract of land was used and the land was plowed nine days before seeding. The land was rolled before seeding, and the oats were covered with a disk harrow and a common tooth harrow.

The oats were blown down more or less each season, which somewhat affected the amount of straw harvested. The plats sown at the rate

of one bushel and one and one-half bushels were generally a very little weedy. No essential difference was noticed in the time of ripening.

The table gives results for the three years.

TABLE SHOWING YIELD OF OATS FROM DIFFERENT AMOUNTS OF SEED, 1888, '89, '90.

Seed per acre, bushels.	Grain, per acre, bu.				Straw per acre, lb.				Lb. per bu.	
	1888.	1889.	1890.	Av'ge.	1888.	1889.	1890.	Av'ge.	1889.	1890.
1	52.5	36.3	25.3	38.0	3,820	4,600	2,820	3,747	25.5	26
1.5	59 4	33.1	21.6	38 0	4,400	3,800	1,740	3,313	25	26.5
2	61.4	42.5	17 5	40.5	4,540	4,000	1,800	3,447	28	24
2.5	63 8	43.8	29.1	45.5	4.860	3.000	2,460	3.440	28	29
3	61.9	47.2	27.5	45.5	5,220	4,400	1,960	3,860	29	29
3.5	62.5	52.1	24.7	46.4	4,400	4.100	2,000	3,500	29.5	28
4	60.6	50.6	21.9	44.4	4,260	3,200	2,020	3,160	29.5	29

Experiment No. 13. Oats, Compact or Loose Seed-Bed.

Three plats, each 2 x 4 rods, were sown broadcast April 6, 1888, at the rate of two and one half bushels per acre.

In plat 1, the oats were sown in fall-plowed land, and lightly covered with a disk harrow. The land was then rolled with a heavy garden roller and afterwards harrowed.

Plat 2 was cultivated with a disk harrow before sowing; the oats were covered by disking once and once harrowing.

Plat 3 was disked three times before sowing, once afterward, and then harrowed.

The oats came up evenly and ripened at the same time. They were harvested July 19th and threshed July 27th to 28th.

March 27, 1889, four plats, each 2 x 4 rods, were sown broadcast with welcome oats at the rate of two and one-half bushels per acre.

In plat 1, the oats were sown on fall-plowed land, and were covered by disking once and harrowing twice.

In plat 2, the oats were sown on fall-plowed land and were covered by harrowing twice. Plats 3 and 4 were treated as were plats 2 and 3 in 1888.

The oats came up and ripened evenly. They were down rather badly on plat 1, less on plat 2, still less on plat 3, and were standing fairly on plat 4, this condition being due probably, to differences in the soil. They were harvested July 19th and threshed August 10th.

April 1, 1890, four plats each 2 x 4 rods, were sown broadcast with welcome oats at the rate of two and one-half bushels per acre. The land, which was used without previous preparation, was partly in the same experment last year and partly in sorghum, each plat being equally so used.

In plat 1, the oats were sown without previous preparation.

In plat 2, the land was disked once before sowing.

In plat 3, the land was disked three times before sowing.

In plat 4, the land was plowed four inches deep just before seeding.

The oats were covered with the disk harrow, the driver walking while going over the plowed plat to prevent the oats being too deeply covered. The whole tract was afterwards harrowed with a common tooth harrow. On several square feet of plat 1, considerable sweet clover sprung up, which was removed May 6th.

July 10th, the oats were harvested, when they were equally ripe and all were standing well. The oats were threshed July 22d.

TABLE SHOWING YIELD OF OATS FROM DIFFERENTLY PREPARED SEED-BEDS, 1888, 1889, 1890.

Seed-bed.	1888.			1889.				1890.				Average.	
	Plat.	Grain, per acre, bu.	Straw, per acre, lb.	Plat.	Grain, per acre, bu.	Straw, per acre, lb.	Lb. per bushel.	Plat.	Grain, per acre, bu.	Straw, per acre, lb.	Lb. per bushel.	Grain, per acre, bu.	Straw, per acre, lb.
Very compact	..	.....	.....	2	40	3,100	25.5	1	30.6	2,220	32	.....	.....
Compact	1	60	4,180	1	44.4	3,200	27	2	36.3	2,040	32	46.9	3,140
Medium	2	66.3	5,380	3	47.8	2,900	27.5	3	32.8	2,020	31	49	3,433
Very loose...	3	60.6	4,460	4	44.1	2,300	30	4	30.3	1,940	33	45	2,900

Experiment No. 14. Oats, Time of Sowing.

Four adjacent plats, each 2 x 4 rods, were sown broadcast, at intervals of one week, from April 6 to April 27, 1888. In 1889, seven plats were sown at intervals of one week, from March 14th to April 25th. In 1890, twelve plats were sown, two each week, from March 22d to April 28th, the duplicate plats being six plats apart. Each season welcome oats were sown on fall-plowed land at the rate of two and one-half bushels per acre and were covered by use of a disk harrow and the common tooth harrow.

May 5, 1890, the first and second weeks' sowings were nearly equal in growth; the third weeks' sowing smaller; the fourth weeks' sowing distinctly smaller; the fifth weeks' still smaller; while the sixth weeks' sowing was just coming up.

June 27th the first three weeks' sowings were fully panicled. July 2d the fourth and fifth weeks' sowings were fully panicled. July 7th the sixth sowing was fully panicled.

The following table gives the results of the duplicate plats for 1890:

TABLE SHOWING YIELD OF OATS FROM SOWINGS OF DIFFERENT DATES, 1890.

Date of sowing, 1890.	Plat.	Grain per acre, bu.	Straw per acre, lb.	Pounds per bu.	Plat.	Grain per acre, bu.	Straw per acre, lb.	Pounds per bu.	Average. Grain per acre, bu.	Average. Straw per acre, lb.	Average. Pounds per bu.
March 22....	1	46 6	3220	32.5	7	41.6	3060	31	44.1	3140	31.8
March 31....	2	42.5	2920	31.5	8	47.8	3860	30.5	45.1	3390	31
April 7.....	3	36.3	2640	27.5	9	36.6	3140	26.5	36.5	2890	27
April 16.....	4	29 4	3060	27.5	10	30.6	2980	27	30.0	3020	27.3
April 21.....	5	28.1	2580	27.5	11	28.1	2900	26	28.1	2740	26.8
April 28.....	6	18.3	2440	26	12	20 9	2640	27.5	19.6	2540	26.8

July 12th, the first three weeks' sowings were harvested; July 17th, the fourth weeks'; July 19th, the fifth weeks'; and July 21st, the sixth weeks'. July 24th to 28th, the oats were threshed. For details of the first two seasons see *bulletin No. 7, p. 195*.

The substantial agreement of the duplicate plats is quite striking. The first two weeks' sowings gave decidedly better results this season than any of the later sowings. A great many acres of oats were sown at a later date in this latitude and farther south.

The percentage of kernel was determined in a five-gram sample taken from each plat, as follows:

TABLE SHOWING PER CENT OF KERNEL IN OATS GROWN FROM SOWINGS AT DIFFERENT DATES, 1890.

Date of sowing, 1890.	Plat.	Per cent of kernel.	Plat.	Per cent of kernel.	Average per cent of kernel.
March 22..	1	70.4	7	70.5	70.5
March 31..	2	68.9	8	69.2	69.1
April 7....	3	63.1	9	64.9	64
April 16...	4	65.4	10	65.4	65.4
April 21...	5	68.2	11	62.9	65.6
April 28...	6	62.5	12	63.8	63.2

The following table gives the yield of straw and grain per acre, for three years:

TABLE SHOWING YIELD OF OATS FROM SOWINGS AT DIFFERENT DATES, 1888, 1889, 1890.

1888.			1889.				1890.				Av'ge bu. grain per acre, 3 yrs.	Av'ge bu. grain per acre, 2 yrs.
Date of sowing.	Grain per acre, bu.	Straw per acre, lb.	Date of sowing.	Grain per acre, bu.	Straw per acre lb.	Pounds per bu.	Date of sowing.	Grain per acre, bu.	Straw per acre, lb.	Pounds per bu.		
.....	.....	....	M'rch 14	48.1	3600	28.5	.....	.....	....	..	.....	.....
.....	.....	....	M'rch 22	41.5	4600	28	M'rch 22	44.1	3140	31.8	.....	42.8
.....	.....	....	M'rch 28	41.3	5200	28.5	M'rch 31	45.1	3390	31	.....	43.2
April 6....	66·3	5080	April 4..	36.3	4000	26.5	April 7..	36.5	2890	27	46.3	36.4
April 13...	56.5	5020	April 11	33.1	4000	25	April 16.	30.	3020	27.3	40.	31.6
April 20...	48.8	5040	April 18.	25	4100	22	April 21.	28.1	2740	26.8	34	26.5
April 26...	49.4	5020	April 25.	9.4	3700	21	April 28.	19.6	2540	26.8	26.1	14.5

Experiment No. 15. Oats, Depth of Sowing.

For three seasons, April 25, 1888, March 28, 1889, and April 16, 1890, sixty selected berries of welcome oats were sown in each of twelve rows, ten feet long. The first two rows were covered one inch deep, and each succeeding two rows one inch deeper, rows 11 and 12 being covered six inches deep. In 1890 as in 1889, an extra row was sown at each side so that the twelve rows in the test would be under similar conditions. For details of the experiment in 1888 and 1889 see *bulletin No. 7, p. 196.*

May 5, 1890, Oats sown one and two inches deep looked the strongest and healthiest. Those sown deeper were slender and weak and were not so upright and stocky. Many of the plants from seed sown five and six inches deep were bent over and lay upon the ground.

The following table gives the items ascertained in 1890:

TABLE SHOWING YIELD OF OATS FROM SOWINGS AT DIFFERENT DEPTHS, 1890.

Row.	No. of plants May 5.	No. of stools harvested.	No. of heads.	Heads per stool.	Oz. of grain and straw.	Oz. of grain.
1	59	57	196	3.4	16.5	4.5
2	58	53	166	3.1	15.5	4
3	60	57	160	2.8	12	2.5
4	58	55	152	2.8	14	4
5	53	51	170	3 3	10	2.5
6	53	44	137	3.1	11.5	3
7	50	39	128	3.3	9.5	2.5
8	52	49	141	2 9	11.5	3
9	39	40	108	2.7	8	1.5
10	32	27	73	2.7	5 5	1
11	17	15	35	2.3	3.5	0.5
12	15	13	40	3.1	2.5	0.5

Below is given the yield of grain in ounces from two rows ten feet long, and the relative yield for 1888, 1889, and 1890. In 1889 the rows sown five and six inches deep were disturbed by some underground animal and are not reported.

TABLE SHOWING ACTUAL AND RELATIVE YIELD OF OATS FROM SOWINGS AT DIFFERENT DEPTHS, 1888, 1889, 1890.

Depth of sowing, in.	1888.		1889.		1890.	
	Yield of grain, oz.	Relative yield.	Yield of grain, oz.	Relative yield.	Yield of grain, oz.	Relative yield.
1	9	90	11.75	81	8.5	100
2	8	80	10	69	6.5	76
3	10	100	11	76	5.5	65
4	9.5	95	14.5	100	5.5	65
5	8	80	.....	.....	2.5	29
6	5.5	55	.....	.....	1	12

Experiment No. 85. Oats, Effect of Sowing Spring Wheat with them.

It is the practice of some farmers in a limited way to sow oats and spring wheat together. Good results have been reported. It has been claimed that spring wheat of good quality has been raised in this way, while when sown alone it was more or less a failure. The total yield of grain has been said to be greater, and it has been urged as an explanation of this result that the wheat and oat roots were differently distributed and hence able jointly to use more completely the food supply of a given area.

A test of this question was attempted in 1889 and again in 1890.

Both seasons nine plats, 2 x 4 rods, were sown with welcome oats and Saskatchewan Fife spring wheat as given in the tables below. In 1889, the grain was sown on fall-plowed land, in 1890 on spring-plowed land. The seed was sown March 27, 1889, and April 2, 1890, and was covered with a disk harrow and a common tooth harrow.

In 1889, the wheat was almost a failure, and of very poor quality. The results are given below.

TABLE SHOWING YIELD OF OATS AND SPRING WHEAT SOWN TOGETHER, 1889.

Plat.	Seed per acre, bu.	Yield, grain per plat, lb.	Bu. per acre.	
			Oats.	Wheat.
1	Oats, 2.5.....	71.5	44	.....
2	Oats, 1.25; wheat, 1.	49	28.2	1.2
3	Oats, 2.5; wheat, 0.5.....	70	41.7	0.9
4	Oats, 2.5; wheat, 0.25....	61	27.2	5.6
5	Oats, 2; wheat, 0.5	59.5	32.9	2
6	Oats, 2; wheat, 0.25.....	50.5	29 4	1.6
7	Oats, 2.25; wheat, 0.25...	51	30.2	0.9
8	Wheat, 2	20 5	.....	6.5
9	Oats, 2.5.....	58	36.1	.....

In 1890, the yield of wheat was rather better and of fairish quality. The conditions are seldom favorable in this locality for the best development of spring wheat.

TABLE SHOWING YIELD OF OATS AND SPRING WHEAT SOWN TOGETHER, 1890.

Plat.	Seed per acre, bu.	Yield, grain per plat, lb.	Bu. per acre.	
			Oats.	Wheat.
1	Oats, 2.5.....	39.5	24	.....
2	Oats, 1.25; wheat, 1.....	50	20.3	5.2
3	Oats, 2.5; wheat, 0.5.....	35	16.2	2.8
4	Oats, 2.5; wheat, 0.25....	39	20.2	1.9
5	Oats, 2; wheat, 0.5	46	23.1	2.8
6	Oats, 2; wheat, 0.25.....	45	22.8	2 8
7	Oats, 2.25; wheat, 0.25...	38.5	20.8	1.2
8	Wheat, 2.....	43	.....	14 3
9	Oats, 2.5...	43	26.3	.....

The preceding table gives the yield for 1890.

From the above tables, it will be seen that in 1889 the six plats sown with varying mixtures of oats and wheat yielded an average of 57 pounds, while the two plats sown with oats alone averaged 65 pounds of grain. In 1890, the six plats sown with a mixture of oats and wheat gave an average of 42 pounds while the two plats sown with oats alone yielded 41 pounds.

In 1889, the plat sown to wheat alone yielded 20.5 pounds, while in 1890 it yielded 43 pounds.

It is evident that in these tests no appreciable increase in yield was obtained by sowing wheat and oats together. From the table given below, it will be seen that the quality of the wheat, as measured by the size of the kernel, was not increased, and that, in general, the percentage

of oats harvested was greater than that sown. This would seem to indicate the better adaptability of the oat than of spring wheat to the conditions under which they were tested in this experiment.

The following table gives the weight of 1,000 berries in grams and the per cent. by weight of berries in the seed and crop of the two grains in 1890. The wheat was so poor in 1889 as to make the results in this direction of little value.

TABLE SHOWING WEIGHTS AND PERCENTAGES OF OATS AND SPRING WHEAT GROWN TOGETHER, 1890.

Plat.	Wt. of 1000 berries in grm		Per cent. by weight of berries in seed and crop.			
			Oats.		Wheat.	
	Oats.	Wheat.	Seed.	Crop.	Seed.	Crop.
1	19.3	.....	100	97	.....	.....
2	17.5	18.4	40	65	60	31
3	18.1	18.1	73	74	27	24
4	20.7	18.0	84	83	16	14
5	20.7	21.9	78	80	32	18
6	23.5	21.3	81	81	19	19
7	20.1	19.1	83	87	17	10
8	.....	23.4	.....	.....	100	100
9	21.3	.....	100	98	.....	.....

Experiment No. 84. Oats, Test of Varieties.

In 1889, thirty varieties of oats were tested by this Station and the results reported in *bulletin No. 7, p. 197.* These varieties have been tested again in 1890 together with seventeen other varieties.

In the following table are the varieties not tested in 1889.

The land used in this experiment had been in corn three years. March 25, 26, 1890, the tract was plowed about four inches deep without

TABLE GIVING NAMES OF VARIETIES FIRST TESTED IN 1890, AND ADDRESS OF SENDER OF SEED.

No. plat.	Name of variety.	Name of sender.	Postoffice.
1 and 48.	Baltic white.....	Johnson & Stokes.....	Philadelphia.
2 and 54.	Golden giant side.....	W. A. Burpee.....	Philadelphia.
3 and 55.	Improved American....	Joseph Harris.....	Rochester, N. Y.
4 and 56.	White Swede.....	S. F. Leonard.....	Chicago.
5 and 57.	Early Lackawanna.....	W. H. Maule.....	Philadelphia.
6 and 58.	Prince Edward's Island.	James M. Thornburn.....	New York.
7 and 59.	Canada white	James M. Thornburn.....	New York.
8.	Black Russian	T. Chester.....	Champaign.
9.	White bonanza.....	T. Chester	Champaign.
10.	Texas red.....	University farm.....	Champaign.
11.	Black Highlander.....	University farm.....	Champaign.
12 and 52.	2d Premium white.....	S. D. LaRosh.....	Pekin, Ill.
13 and 60.	White Victoria	Kentucky Experiment Sta'n.	Lexington, Ky.
47 and 53.	Prolific side.....	Samuel Wilson.....	Mechanicsville, Pa.
49.	White schonen	Wisconsin Experiment Sta'n.	Madison, Wis.
50.	Swedish	Wisconsin Experiment Sta'n.	Madison, Wis.
51.	Improved white Russian	Wisconsin Experiment Sta'n.	Madison, Wis.

removing corn stalks. April 1st it was rolled. April 2d the tract was divided into 60 plats each 2 x 4 rods. A space of from 2.5 to 5 feet was left between plats. Plats 1 to 48 and 52 to 60, inclusive, were sown with the varieties as specified in table p. 360. The oats were sown at the rate, by weight, of two and one-half bu. per acre. They were covered by going over the ground once with a disk harrow. April 8th, plats 49, 50, and 51 were sown with varieties which had not arrived when the other varieties were sown.

Duplicate Plats.

The first question to be determined in tests of this kind is the degree of accuracy of the method employed and the probable limit of error.

Eleven varieties were sown on two plats each. The duplicates were, on an average, about 20 rods apart, so arranged as to give the maximum variation likely to occur on the tract used.

TABLE Showing Yield of Duplicate Plats of Oats, 1890.

Name of variety.	Grain, per acre, bushel.		Lb. straw for each lb. of grain.		Pounds, per bushel.		Weight of 100 berries in grams, crop.		Per cent. of kernel in berries.	
Baltic white	31.9	38.8	3.43	3.10	35.5	35	2.34	2.36	71.5	73.2
Golden giant side	32.2	34.3	3.18	3.11	33	29.5	2.51	2.39	79.1	78.2
Improved American	22 5	27.5	3.50	3.45	28	27	2.82	2.55	68 7	75.4
White Swede	31.9	30.3	2.60	1.78	33.5	33.5	2.50	2.39	66.7	67.3
Early Lackawanna	29.7	35.9	3.41	2.54	33.5	33	2.34	2.18	68.1	70.0
Prince Edward's Island	35.3	28.6	2.53	2.53	29	29	2.33	2.07	72	71.8
Canada white	42.2	30 6	1.92	2.55	33	33	2.46	2.17	66.1	68.3
2d Premium white	44.7	37.2	2.34	2.55	34	30.5	2.33	2.24	66.9	65.2
White Victoria	39.1	34.7	2.76	2.30	33	31 5	2.21	2.02	68.9	69.5
Prolific side	37.5	33.1	3.00	3.75	32	28.5	2.19	2.02	72.3	70.0
Welcome	38.8	41.2	2.57	1.94	28.5	32.5	2.06	2.11	69.4	71.7

The average difference in yield of grain between two plats of the same variety was 5.3 bushels; the least difference, 1.6 bushels; and the greatest difference, 11.6 bushels. If one variety in this test yields five bushels more than another, it does not necessarily indicate that the former was superior, even for this season, to the latter. Differences of twelve bushels per acre may be due to uncontrollable differences in the condition of the test, although such differences are very much less likely to occur. It is worthy of note, however, that the variety which gave the largest yield was grown adjacent to that which gave the poorest yield, and that the five varieties yielding best were widely distributed over the tract used.

There was in several cases a considerable variation in the number of pounds of straw for each pound of grain on the different plats of the same variety.

The greatest difference in the weight of a bushel of oats from two plats of the same variety was four pounds; the average difference about one and one-half pounds. It is probable that the number of pounds of oats in a bushel is less trustworthy than any other item given in the table. The chance of variation in the mere mechanical operation of obtaining the result is very great.

With the exception of improved American (plats 3 and 55) the per-centage of kernel in the berries of oats of the same variety grown on different plats is substantially alike. The average difference is less than one and one-half per cent. and the greatest difference, 2.3 per cent. The samples of improved American contained, as did other samples, a considerable number of hull-less kernels and there seems to have been many more hull-less kernels in oats from plat 55 than from plat 3.

In determining the per cent. of kernel in the berries of the several varieties ten grams of each sample were hulled and the weight of kernel and hulls obtained together with the number of berries. In order to test the accuracy of this method, four subdivisions of a sample of Clydesdale oats were analyzed as follows:

Number of berries	446	446	436	435
Wt. of hulls in ten grams	3,506	3,456	3,361	3,356
Wt. of kernel in ten grams	6,486	6,494	6,594	6,612
Total weight	9,992	9,950	9,955	9,968
Per cent. of kernel	64.9	64.9	65.9	66.1

According to these results the method is accurate within about one per cent., or in other words the limit of error is about one per cent.

Vitality of Seed.

In 1889, twenty-eight varieties of oats, most of which had been received from seedsmen, were tested in the Geneva apparatus for 18 days at the mean temperature of 66.5° F. Ninety-three per cent. sprouted.

A portion of the crop of 1889 was saved for the seed of the crop of 1890. Thirty-two samples, thus saved, were tested in the Geneva apparatus first at a mean temperature 60.4° F., and again at essentially the same mean temperature 60.1° F. The average vitality was 87 per cent, six per cent. less than that shown by the test of a year ago.

Eleven additional varieties—two samples of 100 berries each—were tested at a mean temperature of 63.7° F. The average vitality was 93 per cent.

Purity of Seed.

In 1889, it was shown that the foreign mattter contained in the seed sent to this Station was less than two-tenths of one per cent., and that the impurities were usually of the most harmless nature, such as bits of straw, chaff, etc.

Similar results have been obtained in those varieties which have been sent to this Station the present season.

Synopsis of Varieties.

The early, medium, and late maturing are grouped on p. 364 according to their more striking characteristics, so that the reader may more readily understand the similarities and dissimilarities of the several varieties. This obviates the necessity of a description of each variety. It does not follow that all the names in one final group are but different names for the same variety. There are minor differences between some of the oats which may doubtless constitute variety characteristics; but for ordinary farm purposes these differences are probably unimportant.

Those varieties which were harvested from July 10th to 12th, are classed as early. Plat 59 is an exception. It was harvested July 15th, which was doubtless an oversight, as the same variety on plat 7 was harvested July 11th. The medium maturing varieties are those harvested July 17th and 19th, and the late maturing those harvested July 21st and 23d.

Where the oats are blown down badly it is often difficult to judge correctly as to the comparative ripeness of several varieties.

There are some changes from the classification made in 1889. *Early Dakota, centennial,* and *Hargett's white* are changed from medium maturing to early maturing. *Egyptian* has been changed provisionally from the open to the closed panicle group. Probably other changes will be made from year to year as the experiment progresses.

Yield.

As was commonly the case with oats in this state in 1890, in the experiment under consideration the yield of grain was low, being for the sixty plats an average of 35.2 bushels per acre. The yield of straw was 3,063 pounds per acre. In 1889, the average yield per acre of grain from thirty-three plats was 41.2 bushels; of straw, 2,394 pounds. This year there were 2.8 pounds of straw for each pound of grain produced, while last year there were but 1.84 pounds of straw for each pound of grain. It is evident from this that the oats gave promise in the early part of this season of an abundant yield, but from some cause or causes the fulfillment of that promise was prevented. The problem is too intricate—the effect of climatic conditions and the damage from insect depredations and from the prevalence of plant diseases have been too little studied, to make it possible to speak dogmatically with regard to the failure in this particular case. Suffice it to say that the rainfall (11.47 in.) for the three principal months, April, May, and June, was but little below the normal for the whole season, but was in excess in April, somewhat deficient in May, and considerably more deficient in June, while the temperature for May and June was above normal; and that the oats were somewhat, although not in this case excessively, infested with the grain plant louse, *Aphis avenae.*

The table on page 365 gives for the several plats, in order, the yield of grain per acre, beginning with the highest, while the table on pages 365–6 gives more details both with regard to the yield and quality of the grain.

SYNOPSIS OF VARIETIES.

					Yield, bu.
Oats.	Early.	Open panicle..	Dun.. ..	Berry long	Texas rust proof.....55 0
					Texas red.....49 7 } 50.2
					New red rust proof.....45 0
			White ..	Berry long	Early Dakota.....48 8
					Pringle's progress.....48 1 } 48.5
				Berry short	White Swede.....31 1
					Early Lackawanna.....32 8
					Canada white.....36 4
					White bonanza.....37 7
					Second premium.....42 0
					White Victoria.....36 9
					Welcome.....37 2
					Clydesdale.....32 8 } 35.7
					Hopetown.....35 9
					White wonder.....35 6
					Prize cluster.....37 2
					Badger queen.....37 8
					White Belgian.....33 8
					Hargett's white.....34 4
					Centennial.....33 4
		Closed panicle.	Black ..	Berry long	Black Russian.....35 0
	Medium.	Closed panicle.	Black ..	Berry long	Black Russian.....40 6
					New Dakota gray.....39 4
					Black prolific.....35 9 } 37.0
					Prince Edward's Island..32 0
			White ..	Berry long	Prolific side.....35 3
				Berry short	Japan.....40 3
					Baltic white.....35 4
					Probstier.....35 6 } 36.8
					Egyptian.....35 9
		Open panicle..	White ..	Berry short	Swedish.....30 9
					Wide awake.....28 6 } 28.1
					Improved American.....24 8
				Berry long	White schonen.....31 9
					American banner.....30 6 } 30.1
					American triumph.....27 8
			Black ..	Berry long	Black Tartarian.....33 8
	Late.	Open panicle..	Black ..	Berry long	Canadian black.....34 4
			Dun....	Berry long	Virginia winter.....20 0
		Closed panicle.	Black ..	Berry long	Black Highlander.....36 3
			White ..	Berry long	Golden giant side.....33 3
					Giant yellow French.....34 4
					Common mixed.....31 9 } 30.3
					White Russian.....26 6
					Improved white Russian.25 6

It is a striking fact, as will be seen from the tables, on page 365, that many of the varieties yielded nearly alike. Thirty-three varieties yielded between thirty and forty bushels per acre; that is, they did not vary over five bushels above or below the average of all the varieties.

Only five varieties, *Texas rust proof*, *Texas red*, *Early Dakota*, *Pringle's progress*, and *new red rust proof* stands conspicuously above the other varieties, *Texas rust proof*, stands somewhat ahead of any other. This

TABLE SHOWING COMPARATIVE YIELD OF VARIRTIES OF OATS—1890.

NAME OF VARIETY.	Bu. per Acre.	COMPARATIVE YIELD.
Texas rust proof	55.9	
Texas red	49.7	
Early Dakota	48.8	
Pringle's progress	48.1	
New red rust proof	45.0	
Second premium	42.0	
Black Russian	40.6	
Japan	40.3	
New Dakota gray	39.4	
Welcome	38.4	
White bonanza	37.8	
Badger queen	37.8	
White bonanza	37.5	
Prize cluster,	37.2	
White Victoria	36.9	
Canada white	36.4	
Black Highlander	36.3	
Hopetown	35.9	
Egyptian	35.9	
Black prolific	35.9	
Probstier	35.6	
White wonder	35.6	
Baltic white	35.4	
Prolific side	35.3	
Black Russian	35.0	
Giant yellow French	34.4	
Hargett's white	34.4	
Canadian black	34.4	
Clydesdale	33 8	
White Belgian	33.8	
Welcome	33.8	
Black Tartarian	33.8	
Centennial	33.4	
Golden giant side	33 3	
Early Lackawanna	32 8	
Prince Edward's Island	32.0	
Common, Mixed	31.9	
White Schonen	31.9	
White Swede	31.1	
Swedish	30.9	
American banner	30.6	
Wide awake	28.6	
American triumph	27.8	
White Russian	26.6	
Improved W. Russian	25.6	
Improved American	25.0	
Improved American	24.4	
Virginia winter	20.0	

TABLE SHOWING YIELD OF OATS OF DIFFERENT VARIETIES; WEIGHT PER BUSHEL; HEIGHT; DATE OF RIPENING; WEIGHT OF BERRIES; PER CENT. OF KERNEL,—1890.

No. of plat.	Name of Variety.	Yield per acre		Lb. straw for each lb. grain.	Pounds per bushel.	Height, feet.	Ripe and cut July.	Wt. of 100 berries in grams.		Per cent. of kernel in berries.		Condition when cut.
		Grain, bu.	Straw, lb.					In seed.	In crop.	In seed.	In crop.	
1	Baltic white	31.9	3500	3.43	35.5	4.25	19	2.55	2.34	68.5	71.5	Badly down
2	Golden giant side	32.2	3280	3.18	33	4 25	21	1.99	2.51	71.1	79.1	Standing fairly
3	Improved American (Harris)	22.5	2520	3.50	28	3 75	19	2.89	2.82	71.3	68.7	Standing
4	White Swede	31.9	2660	2.60	33.5	4.50	11	2.91	2.50	65	66.7	Considerably down
5	Early Lackawanna	29.7	3240	3.41	33.5	4 50	10	2.59	2.34	67.3	68.1	Considerably down
6	Prince Edward's Island	35.3	2860	2.53	29	3.5	19	3.01	2.33	74	72	Standing fairly
7	Canada white	42.2	2600	1.92	33	4 25	11	2.28	2.46	67.7	66.1	Considerably down
8	Black Russian (Chester)	35	1880	1.67	33	3.75	11	2.55	2.06	71.6	75.8	Some down,
9	White bonanza (Chester)	37.5	2560	2.13	33.5	4.25	10	2.20	2.53	64.7	64 9	Considerably down
10	Texas red	49.7	2760	1.74	32.5	3.5	11	2.36	2.37	65.9	75.8	Considerably down
11	Black Highlander	36.3	4000	3.44	29	4	21	2.07	2.24	64.5	72.1	Badly down
12	2d Prem. white	44.7	3360	2.34	34	4.5	10	2.33	2.33	63	66 9	Considerably down
13	White Victoria	39.1	3460	2.76	33	4 25	11	2.21	2.21	65.6	68.9	Badly down
14	Welcome	38.8	3400	2.57	28.5	4.5	11	2.13	2.06	66	69.4	Considerably down
15	Clydesdale	33.8	2960	2.74	34	4.5	11	2.32	2.24	61.5	64.8	Badly down
16	Probsteier	35.6	3260	2.86	37	4	17	2.11	2.55	61	72 1	Badly down
17	Hopetown	35.9	3360	2.92	35	4.5	10	2.43	2.13	63	66.6	Badly down
18	Early Dakota	48.8	2840	1.82	28	4.25	11	1.87	2.34	70.2	73 6	Badly down
19	White bonanza (Salzer)	37.8	2940	2.42	34	4.5	11	2.66	2.44	61.5	67.8	Badly down
20	White wonder	35.6	2540	2.22	35	4.25	10	2.81	2.42	62.7	65.7	Badly down
21	Wide awake	28.6	2720	2.99	30.5	4	19	2.51	2.44	67.5	74.5	Some down
22	Japan	40.3	3660	2.83	32	4	19	2.21	2.51	65.1	71.4	Badly down

23	Prize cluster	37.2	3200	2.68	33.5	4.5	11	2.47	2.31	63.5	68	Considerably down.
24	Giant yellow French	34.4	3300	3.00	30	4.5	21	2.21	2.63	69.5	76.3	Standing fairly
25	Badger queen	37.8	1300	1.07	33.5	4.5	11	2.39	2.35	63	66.6	Considerably down.
26	White Belgian	33.8	3120	2.89	33	4.5	12	2.21	2.16	61	66.1	Badly down.
27	American banner	30.6	2740	2.79	30	4	19	2.16	2.72	68.5	72.3	Standing fairly
28	Egyptian	35.9	3320	2.88	33.5	4.25	17	2.06	2.46	62	70.8	Badly down.
29	Welcome (Vaughan)	33.8	3040	2.81	33	4.5	11	2.29	2.16	60.7	67.6	Badly down.
30	Welcome	35	3200	2.86	32	4.25	11	2.13	2.20	.....	70.9	Badly down
31	Improved American (Department Agriculture).	24.4	2420	3.10	24.5	3.75	19	2.29	2.33	68.7	73.3	Standing fairly
32	Hargett's white	34.4	2700	2.45	33	4.25	11	1.99	2.20	60.7	67.3	Badly down
33	Centennial	33.4	2640	2.47	33	4.25	11	1.98	2.33	65.5	70.7	Badly down
34	White Russian	26 6	3220	3.79	32.5	4.25	21	2.13	2 63	70.6	77.3	Standing fairly
35	Virginia winter	20	3000	4.69	29	3.25	23	1.76	2.29	69.5	78.4	Standing fairly.
36	Texas rust proof	55.9	3320	1.85	31.5	3.75	12	2.37	2.71	64.5	74.5	Badly down
37	New red rust proof	45	2640	1.83	30	3.5	12	2.28	2.78	66.8	73.6	Considerably down.
38	Black Russian	40.6	3820	2.94	27	3.75	19	1.94	2.17	64	71.6	Badly down
39	Black Tartarian	33.8	3960	3.67	28	4.75	17	2.68	1.79	59.7	65	Badly down
40	Canadian black	34.4	4180	3.80	30.5	4	23	1.86	2.06	71.7	80.8	Badly down
41	Black prolific	35.9	3800	3.30	30	3.75	19	1.84	2.24	65.5	73.9	Badly down
42	New Dakota gray	39.4	3980	3.16	31.5	3.5	19	1.94	2.26	63	74	Badly down
43	Common mixed	31.9	3740	3.67	32	4.5	21	2.16	2.40	71	77	Badly down
44	American triumph	27.8	3020	3.39	29	4.25	19	1.74	1.98	64.2	73.5	Badly down
35	Pringle's progress	48.1	2580	1.68	27	3.75	10	2.28	2.14	66.5	70.5	Badly down
46	Welcome	41.3	2560	1.94	32.5	4.5	11	.....	2.11	.....	71.7	Considerably down.
47	Prolific side	37.5	3600	3.00	32	4.75	17	2.27	2.19	64.2	72.3	Badly down
48	Baltic white	38.8	3840	3.10	35	4.5	19	2.55	2.36	68.5	73.2	Badly down.
49	White schonen	31.9	2580	2.53	28	4	17	2.16	2.45	64.1	74.8	Considerably down.
50	Swedish	30.9	3320	3.35	29.5	4.5	17	2.33	2.18	63.5	74.6	Badly down
51	Improved white Russian	25.6	3780	4.61	30	4	23	2.10	2.32	70.7	74 9	Badly down
52	2d premium white	37.2	3040	2.55	30.5	4.25	11	2.33	2.24	63	65.2	Considerably down.
53	Prolific side	33.1	3980	3.75	28.5	4.5	17	2.27	2.02	64.2	70	Badly down
54	Golden giant side	34.3	3420	3.11	29.5	4.25	21	1.99	2.39	71 1	78.2	Considerably down.
55	Improved American (Harris)	27.5	3040	3.45	27	3.75	17	2.89	2.55	71.3	75.4	Standing fairly
56	White Swede	30.3	1740	1.78	33.5	4.25	11	2.91	2.39	65	67.3	Considerably down
57	Early Lackawana	35.9	2920	2.54	33	4.25	11	2.59	2.18	67.3	70	Considerably down.
58	Prince Edward's Island	28.6	2300	2.53	29	3.75	19	3.01	2.07	74	71.8	Standing fairly
59	Canada white	30.6	2500	2.55	33	4.25	15	2.28	2 17	67.7	68 3	Considerably down.
60	White Victoria	34 7	2560	2.30	31.5	4.5	11	2 21	2.02	65.6	69.5	Considerably down.
	Average	35 2	3063	2.80	31.4	.....	.....	2.31	2.32	66·2	71.3	.....

variety gave the poorest yield in 1889. *Giant yellow French*, which last year gave the best yield, this year yielded indifferently. *Early Dakota* is the only variety which yielded especially well both seasons. It gave the second best yield last season, 51.3 bushels, and the third best yield this season, 48.8 bushels.

Quality.

The quality of the several varieties, as indicated by the ratio of kernel to berry has been studied again this season, and is shown in the table on pages 366–7. There was an average of 66.2 per cent. of kernel in the seed and 71.3 per cent. in the crop. In 1889, there was 69.6 per cent. of kernel in the seed and 65.1 per cent. in the crop. In other words there was a decrease of 4.5 per cent. in 1889, and an increase of 5.1 per cent. in 1890, in the crop as compared with the seed. This season there were more kernels without hulls than last season, which was one reason for the increased percentage of kernel. Whether this was due to the conditions of growth or to the differences in handling cannot be told.

In 1889, *Canadian black* had the largest per cent. of kernel, 78 1 in the seed. In 1890, the same variety had the largest per cent. of kernel, 80.8, in the resulting crop. The least per cent. of kernel in the seed sown was 59, in *black Tartarian* and the least in the crop was 64.8, in *Clydesdale*; and the per cent. was almost as low in *black Tartarian*.

There was a difference of 15 per cent. between the highest and lowest per cent. of kernel in the seed, and a difference of 16 per cent. between the highest and lowest per cent. of kernel in the crop. It was shown in bulletin No. 7, p. 207, that these differences were a matter of some importance to the individual oat raiser and of vast importance when applied to the total crop of the United States.

On thirty-four plats the varieties whose seed had in each case more than 65 per cent. of kernel and an average of 68.6 per cent., contained in the crop 72.8 per cent. of kernel. From twenty-four plats varieties whose seed had in each case less than 65 per cent. of kernel and an average of 62.8 per cent., contained in the crop 69.7 per cent. of kernel. The average yield of the former class was 34 bushels, while that of the latter was 36.6 bushels. That is, in 1890 those varieties whose seed had the largest per cent. of kernel averaged the largest per cent. in the crop. Unlike last year, however, those varieties having the less per cent. of kernel in the seed gave the larger crop of grain. On the thirty-six plats the varieties which had in the crop more than 70 per cent. of kernel, gave the same average yield as the varieties from twenty-two plats which had less than 70 per cent. of kernel in the crop.

The average weight of the berries harvested was equal to that of those sown. It appears, therefore, that the deficiency in yield was due to a less number of berries rather than to a decrease in the weight of the berry.

Thus it is seen that there is a wide variation in the yield, and to some, but apparently less extent, in the quality of individual varieties. The question arises, therefore, whether there is any traceable relation between the more striking characteristics of the oat, as time of ripening, color, size, and shape of berry, weight per bushel, etc., and the yield and quality. The table below shows that the following were the facts in this experiment in 1890:

TABLE SHOWING FOR DIFFERENT VARIETIES AS CLASSIFIED, YIELD, WEIGHT OF GRAIN, PER CENT OF KERNEL, 1890.

Varieties Classified.	No. of plat.	Bu. per acre of grain.	Lb. per acre of straw.	Lb. straw for each lb. grain.	Lb. per bushel.	Grams per 100 berries of seed.	Grams per 100 berries of crop.	Per cent of kernel in seed.	Per cent of kernel in crop.
Maturing early	30	38.2	2787	2.32	32.5	2.36	2.30	64.9	68.8
Maturing medium	21	32.9	3250	3.10	30.1	2.35	2.32	66.3	69.0
Maturing late	9	30.6	3546	3.70	30 6	2.03	2.39	70.0	72.2
Berries, short, plump	34	34.7	2918	2.66	32.2	2.47	2.33	65.0	77.1
Berries, long, slender	26	35.9	3253	2.98	30.4	2.39	2.31	67.7	74.2
Berries, white	47	34.5	3006	2.78	31.9	2.30	2.34	65 9	70 6
Berries, black	9	35.5	3420	3.00	29.7	2.32	2.44	67.5	73.0
Berries, dun-colored	4	42.7	2930	2.53	30.8	2.19	2.54	66.7	75.6
Panicles, open	40	35.6	2881	2.63	31.4	2.34	2.33	65.4	70.1
Panicles, closed	20	34.5	3427	3.14	31.5	2.25	2.33	67.7	73.8
Weight per bushel, 32 lb. or more	32	35.9	2958	2.61	33.4	2.35	2.34	65.2	69.8
Weight per bushel, less than 32 lb	28	34.4	3183	3.01	29.1	2.25	2.30	67.1	72.9
Weight of seed per 100 berries, 2.25 grains or more	32	35.7	2895	2.62	31.6	2.52	2.32	66.0	69.9
Weight of seed per 100 berries, less than 2.25 grains	26	34.4	3284	3.05	31.1	2.05	2.33	66.4	73.0
Kernel in seed, 65 per cent or more	34	34.0	2992	2.85	31.0	2.34	2.36	68.6	72.8
Kernel in seed, less than 65 per cent	24	36.6	3178	2.75	31.9	2.27	2.27	62.6	69.3
Kernel in crop, 70 per cent or more	36	35.1	3202	2.97	30.6	2.23	2.35	67.5	73.9
Kernel in crop, less than 70 per cent	22	35.1	2853	2.55	32.6	2.43	2.29	64.0	67.2

Date of Ripening. The extreme difference in the ripening of the several varieties was but thirteen days. The early ripening varieties yielded appreciably more grain than the medium maturing, and the medium maturing somewhat more than the late maturing. The yield of straw was in the reverse order, being over one-fourth more in the late than in the early maturing varieties, and the proportion of straw to grain was over one-half more.

The percentage of kernel both in the seed and in the crop was the greatest in the late maturing and the least in the early maturing varieties. In regard to quality this agrees with the results of last season. Last season there was no determinable relationship between the date of ripening and the yield. This season the yield of the early maturing varieties is

increased by the fact that the three heavy yielding dun varieties came into this group. If they are left out, however, the yield of the early maturing varieties is still considerably above the other varieties.

Panicles. Those varieties with open or branching panicles yielded slightly more grain and considerably less straw than those with closed panicles, sometimes called side oats. Eight of the twelve varieties in the last group were black. The varieties with closed panicles had the largest per cent. of kernel both in the seed and the crop.

Color. The black varieties yielded one bushel of grain and about 400 pounds more of straw per acre than the white varieties. The dun-colored varieties yielded about seven bushels of grain and 500 pounds of straw less per acre than the black varieties. One of the dun-colored varieties yielded 20 bushels only of grain, and is otherwise different from the remaining three. Omitting this one, the dun-colored varieties yielded about fifteen bushels more than the black varieties and sixteen more than the white varieties.

The percentage of kernel was most in the dun-colored varieties and least in the white varieties. Last season the white varieties yielded decidedly the best and the dun-colored varieties the poorest. The dun-colored varieties had, last season and this, the largest per cent. of kernel; but the black instead of the white varieties, had the least per cent. of kernel.

Plumpness of berry. The varieties with short plump berries did not yield quite so much grain or straw as those varieties with long slender berries. The per cent. of kernel was in favor of the latter both in the seed and the crop.

Weight per bushel. The varieties which weighed 32 or more pounds per bushel yielded slightly more grain and less straw than those that weighed less than 32 pounds per bushel. The per cent. of kernel was distinctly in favor of varieties which weighed less than 32 pounds per bushel. The varieties with the heavier berries gave substantially the same results.

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MILK AND BUTTER TESTS.

At the request of the Illinois State Board of Agriculture, through Mr. E. E. Chester, superintendent of the dairy cattle department, Mr. E. H. Farrington, of this Station, made chemical analysis of the milk of the cows competing for certain prizes at the State Fair held at Peoria, September 29 to October 3, 1890. These prizes were in two classes—for cows

under and over three years of age—for each of the recognized dairy breeds, the awards to be made to cows whose milk, produced in 24 hours during the progress of the fair, should show the greatest quantity of fat.

For these prizes 18 cows competed—6 Ayrshires, 5 Holstein-Friesians, 5 Jerseys, and 2 Shorthorns. All were pure-bred cattle; most, if not all, had recently been shown at a series of fairs in different states.

The accompanying table presents, in part, the results of these tests:

MILK YIELD AND COMPOSITION OF MILK OF COWS OF DIFFERENT BREEDS, ILLINOIS STATE FAIR, 1890.

Breed.	Age, yrs.	Milk, lb. in 24 hours.	Fat, lb.	Fat, per cent.	Total solids, per cent.	Solids, other than fat, per cent.
Ayrshire	5	31.00	1.19	3.83	13.12	9.29
	8	29.00	0.90	3.10	11.01	7.91
	8	29.00	0.91	3.13	11.94	8.81
	5	30.00	0.95	3.16	11.46	8.30
	2	21.50	0.70	3.25	11.65	8.40
	2	17.50	0.61	3.48	12.87	9.39
Average	....	26.3	.87	3.32	12.00	8.68
Jersey	3	25.00	1.47	5.40	15.46	10.06
	4	27.00	1.71	6.33	14.77	8.44
	4	17.50	1.18	6.74	15.80	9.06
	2	18.00	0.80	4.44	14.85	10.41
	2	19.50	0 99	5.06	14.65	9.59
Average	....	21.40	1.19	5.59	15.10	9.51
Holstein-Friesian	7	68.25	2.51	3.67	11.78	8.11
	10	61.75	1.34	2.17	10.81	8.64
	12	64.75	2.18	3.36	11.89	8.53
	6	37.50	1.23	3.28	11.11	7.83
	2	51.50	1.67	3.24	11.92	8.68
Average	....	56.75	1.78	3.14	11.50	8.36
Shorthorn	9	24.50	0.95	3.87	12.31	8.44
	6	21.50	0.83	3.86	12.63	8.77
Average	....	23.00	0.89	3.86	12.47	8.61
General average	....	33.04	1.23	3.96	12.77	8.81

In studying this table it is well to bear in mind that the rule that a single trial cannot conclusively settle all questions at issue, is especially applicable to a test of this kind. The comparative standing of different cows of different breeds depends, in large degree, on conditions not shown in the table. Under the regulations of the State Board of Agriculture the award was made on the quantity of fat produced without reference to quantity or quality of food, time since calving, pregnancy, size of cow, etc. In a test of this kind it is difficult to secure equally creditable representatives of the different breeds.

In this test quantity of milk proved to be as important as large percentage of fat. All the prizes were awarded to the cows giving the largest quantities of milk in their classes. The milk of the first and second

prize Jersey cows had not so large a percentage of fat as that of one other Jersey cow. The first prize young Aryshire cow had a slightly lower percentage of fat in her milk than did the second prize cow in same class. In the case of the older Aryshire, Holstein, and Shorthorns, the cows giving the largest yield of milk had also the largest percentage of fat.

Three of the Holstein cows gave yields of milk unusually large for a show-yard test—averaging almost 65 pounds each, which was more than twice as much as was given by any cow of any of the other breed. The average milk yield of the five Holsteins was more than twice the average in any of the other breeds. This larger yield more than counterbalanced the lower percentage of fat, so that the average quantity of fat produced by the five Holsteins was greater than that produced by any cow of any of the other breeds and twice the average of either the Ayrshires or Shorthorns. The average percentage of fat, of solids other than fat, and of total solids was lower than in either of the other breeds. One cow had a noticeably low percentage of fat.

The Ayrshires were remarkably uniform in quantity and quality of milk, the four cows over three years old having but two pounds variation in milk yield, and comparatively little in percentage of fat. The average percentage of both fat and total solids was low.

The Jerseys gave the smallest average yield of milk, but showed a high average percentage of fat, of total solids, and of solids other than fat. There was greater variation in the percentage of fat in the milk of the Jerseys than in that of either of the other breeds.

The two Shorthorn cows gave milk of almost identical composition, having a moderate percentage of fat and total solids. Their yield of milk was less than that of the Ayrshires and but very little larger than that of the Jerseys.

The general average results, taking the 18 cows as one herd of mixed character as to breed and age, are interesting and make a creditable showing. An average milk yield of nearly 32 pounds per day, and almost one and one-fourth pounds of fat per cow, is above the average results obtained in practice. The differences to be found in such a herd are also well illustrated. Four of the cows gave an average of a little over two pounds of fat; four others a little less than three-fourths of a pound each. One-half the herd gave an average of about 1.6 pounds of fat; the other half about .85 of a pound each.

The differences in the composition of the milk of different cows, or the average composition of that of cows of different breeds is much more important than appears, if we think of these differences in comparison with the milk as a whole. If we take the average percentage of fat in the milk of the cows of different breeds, it will be seen that, in equal quantities the Jersey milk would have 78 per cent. more fat than the Holstein, 68 more than the Ayrshire, and 44 more than the Shorthorn. The differences in the milk of single cows is still more striking. In equal quantities the richest milk of a Jersey cow had 3.1 times as much fat as

that of the Holstein with exceptionally low percentage of fat; 2.1 times as much as that of one Aryshire; 1.7 times as much as that of either Shorthorn, and 1.5 times as much as that of one other Jersey. If the milk was bought on the basis of quantity of fat contained in it, a pound of the milk of this Jersey cow would be worth more than three times as much as a pound of the milk of the cow with the lowest per cent. of fat.

If the milk was bought with sole reference to its value for butter making, it is possible there would be even more difference in value than is indicated by the differences in the fat. It is impossible to secure all the fat in the milk by any system of cream separation in practical use. The skim milk from different cows may show the same percentage of fat, but this is obviously a less percentage of the total fat in rich than in poor milk. As much as one per cent. of fat may be found in skim milk in some cases. This would be almost one-half the fat in the milk of one cow in this test, and less than one-sixth of that of one other. When milk is set under conditions favorable for cream raising, and especially when the centrifugal separator is used, the percentage of fat left in the skim milk is comparatively unimportant.

Fat is not the only valuable element in milk. The other solids have also a decided value. Less difference is found in this test when the solids other than fat are compared with each other than in the case of the fat. The greatest difference in this respect in the milk of any two cows is a little less than 33 per cent.; while the greatest difference in the average milk of the cows of different breeds is 13 per cent. in favor of the Jerseys as compared with the Holsteins.

It is a mistake to consider only quantity of milk or only percentage of fat in the milk of a cow in determining her value.

The four Holsteins giving the largest yield of milk were milked three times during the day—noon, evening, and morning. It was noticeable that in each case the morning's milk of these cows showed a considerable less percentage of fat than in that given either at noon or at night. In one case the night milk showed 4.45 and the morning, 2.68 per cent. of fat. The one Holstein cow which was milked but twice, also had a less percentage of fat in the morning's than in the night's milk. Of the other 13 cows, six had less in the night and seven less in the morning milk. One Ayrshire cow showed only 2.12 per cent. of fat at night and 4.16 per cent. in the morning. With the care taken in securing a fair sample of milk in each case, and in analyzing the milk, there is no reasonable doubt that the percentages of fat given are correct; but the differences noted give additional emphasis to the fact that no single test can be conclusive.

Some interesting comparisons with the results at this trial are suggested by the results of the milking trials at the show of the British Dairy Farmers' Association, held in London, the first week in October, partial reports of which have been received. At this show 39 cows went through the trial, lasting two days. In making the awards of prizes not only was

the weight of fat considered, but the weight of solids other than fat, and of the whole milk, as well as the time since calving, were taken into account, with a deduction of 10 "points" if less than three per cent. of fat was found in the milk given at any one of the four milkings.

The accompanying table gives a summary of the results for the Shorthorn, Jersey, and Guernsey cows and heifers standing highest in their classes, and for a single cow of each of the following breeds: Ayrshire, Dutch, Red Poll, and Dexter Kerry, the only ones of which reports are at hand.

MILK YIELD AND COMPOSITION OF MILK OF COWS OF DIFFERENT BREEDS, *Show of British Dairy Farmers' Association, October, 1890.*

Breed and Class.	Milk lb. in 24 hours.	Fat, lb.	Fat, per cent.	Total solids, per cent.	Solids other than fat, per ct.
Shorthorn cows	55.2	2.27	4.10	13.46	9 36
	56.7	1.86	3.29	11 79	8 50
	59.7	2.04	3.44	11 81	8 37
Shorthorn heifer	29.2	1.32	4.52	14 09	9 57
Jersey cows	31.9	1.89	5.92	15 51	9 59
	27.8	1.79	6.43	15 60	9 17
	36.2	1.84	5 08	14 83	9 75
Jersey heifers	30.4	1.79	5.88	15 71	9 83
	29.1	1.45	4.98	14 36	9 38
	29.5	1.23	4.20	13 08	8 88
Guernseys	49.2	2	4.08	13 02	8 94
	35.5	1.8	5.03	14 83	9 80
	26.4	1.2	4.54	13 48	8 94
Dutch cow	45	1.85	4.11	12 71	8 60
Ayrshire cow	45.3	1.88	4.15	12 91	8 76
Red Poll Cow	29.1	1.14	3.09	11 95	8 86
Dexter Kerry cow	26.6	1.33	5.00	13 56	8 56

In striking contrast with the Peoria trial are the large yields of milk by the Shorthorn cows and the one Ayrshire, and the creditable quantity of fat produced by them. No one cow produced so much fat as the first prize Holstein-Friesian cow at Peoria. Eleven of the seventeen cows gave more than one and three-fourths pounds of fat in a day.

The fuller report from which the above table is compiled shows more striking variations in the results in the milkings of the same cow. The daily milk yield of two or three cows varied more than five pounds in the two days. In the case of one Shorthorn cow the evening milk showed twice the percentage of fat found in the morning milk. This cow, No. 3 of the table, and the first prize Guernsey cow suffered a loss of 10 "points" because the fat in their morning milk was below 3 per cent.

During the progress of this show the *English Jersey Cattle Society* made a test of churning one day's milk of each of 13 Jersey cows and heifers. The largest yields were 2.21 and 2.09 pounds of butter. Seven

other cows gave more than 1.50 pounds. The largest yield of milk was 43.87 pounds. Of the milk of the first prize cow 14.28 pounds made a pound of butter. Of that of the cow giving the largest yield of milk, 28.36 pounds were required. The very creditable average result for the 13 cows and heifers was: 31 pounds milk, 1.67 pounds butter. One cow was in both tests. The result in butter was almost exactly the same as the average quantity of fat found in her milk during the two days' test.

These two trials were of cows of different breeds competing for prizes. Equally striking differences may be found in farm dairies, and any farmer milking cows has a direct interest in ascertaining the facts concerning them. Thus a dairy of 35 cows, near Urbana, was visited by a representative of this Experiment Station, who weighed the milk from each cow and took a sample of it. This was done at each of the two milkings in 24 hours and the percentage of fat determined in the 70 samples so collected. The cows were in their winter quarters, were of fair average weight, and in good flesh.

Arranging the results according to the per cents of fat found shows that in the night's milk

2	cows	gave	milk	having	between	2	and	3	per cent.	of fat.
21	"	"	"	"	"	3	"	4	"	"
9	"	"	"	"	"	4	"	5	"	"
3	"	"	"	"	"	5	"	6	"	"

In the evening's milk

5	cows	gave	milk	having	between	2	and	3	per cent.	of fat.
14	"	"	"	"	"	3	"	4	"	"
9	"	"	"	"	"	4	"	5	"	"
2	"	"	"	"	"	5	"	6	"	"
1	cow	"	"	"	over			6	"	"

The average per cent. of fat per cow in the night's milk was 3.8; in the morning's, 4.2.

Dividing the herd into lots of seven we find one fifth giving an average of 5.35 per cent. of fat; while another fifth gave an average of 2.86 per cent. of fat—only a little over one-half as much.

The cows gave small yields of milk; the average per cow for 24 hours was 11.87 lb.; highest yield, 29 lb.; lowest yield, 5½ lb. The average quantity of fat was 0.45 lb.; highest, 1 lb.; lowest, 0.25 lb.

The importance of care in securing a fair sample of all the milk is shown by the following illustrations, purposely made extreme. A very small quantity of the first and also of the last milk drawn from each of three cows in the University herd was tested with this result:

	Per cent. of fat.	
	First milk.	Last milk.
Holstein	2.0	6.2
Jersey	1.0	9.9
Jersey	1.5	8.8

A sample of the combined milk of the three cows showed 4.9 per cent. of fat.

G. E. MORROW, A. M., *Agriculturist.*

CREAM RAISING BY DILUTION.

Experiment No. 115.

A series of experiments was made in September last, to determine the effect of diluting milk with water when setting it for cream raising. As further experiments in this direction are to be made, the results are not given in detail.

In these experiments the milk was set in glass vessels three inches in diameter, filled to the depth of 8 inches, a little more than one quart of milk being used in each case. In one series of the experiments the milk was set when at 95° F.; in another at 90° F. The water added varied in the different trials from 53° F. to 57° F.; the air temperature from 46° F. (in the night) to 75° F.

In every case the addition of water caused the cream to rise more quickly than when water was not added; and in all cases the time decreased as the percentage of water increased. When the mixture was equal quantities of water and milk, nearly all the fat secured apparently rose within one hour, or one and one-half hours, the volume of cream decreasing after this time.

When no water was added the volume of cream continued to increase for at least ten hours. In one case about one-half the fat only rose in ten hours when no water was added, nearly one-half of the remainder rising after the milk was allowed to stand 16 hours longer; while nearly three-fourths rose in ten hours (probably much less) when an equal quantity of water had been added to the milk and only a very small additional percentage was secured because of the additional 16 hours' standing.

When the water was added to the milk, especially if in equal volume, the cream not only rose more quickly, but the line of separation was quite distinct from the first hour. When no water was added the line of separation was indistinct for several hours.

When the milk was set in moderately cool water the fat was more completely separated than when in the air, but here, as in the other case, the dilution with water hastened the rising of the cream and left a smaller percentage of fat.

In trials with the milk of individual cows, it was proved that the cream rose much more completely from the milk of some cows than from that of others, not only when the milk of each cow was set by itself, but when an equal quantity of water was added. In the case of one Jersey cow, the skim milk had .93 per cent of fat; that of two Holstein cows, under like conditions, 1.24 and 1.35 respectfully. This when the undiluted milk was set for 15 hours. When an equal volume of water was added to the milk, the differences were much more marked and smaller percentages were in the milk of the Holstein. Corrected for the water added, the skim milk showed fat percentage as follows: Jersey, 1.21; Holsteins, .60 and .45, respectively.

These experiments do not make it probable that adding water to the milk is a desirable substitute for setting in cold or ice water. They do suggest that dilution may be helpful if ice or a considerable quantity of cold water cannot be secured. They do not clearly show the influence of a higher or lower temperature of the water added.

The more rapid rising of the cream is an advantage, and the dilution and consequent lessened value of the skim milk is a disadvantage, of the dilution method.

There is a possibility of being easily misled as to the gain from diluting the milk. The cream not only rises more quickly, but is thinner; that is, contains less fat in a given volume than when no water is added, while the diluted skim milk will look bluer, and chemical analysis will, of course, show a less percentage of fat in it, because of the added water.

G. E. MORROW, A. M., *Agriculturist.*
E. H. FARRINGTON, M. S., *Assistant Chemist.*

THE HESSIAN FLY.

The very general occurrence of the Hessian fly this season in destructive numbers in parts of central Illinois where it is but little known by the practical farmer, and where the most important preventive measures are not commonly understood, makes it desirable that a general account of the principal facts in its life history and economic relations should be now presented.

The views of the history and habits of this insect current among those who suffer from its ravages, are often confused and largely erroneous, chiefly because the egg is minute and almost never seen by the ordinary observer, the young maggot being commonly mistaken for it,—and because very few have ever recognized or seen the adult winged insect.

The Hessian fly is, in this state, practically a wheat insect only, its occurrence here in rye being merely occasional. Each generation goes through the four distinct stages of (1) the egg, (2) the maggot or larva, (3) the pupa or "flaxseed," and (4) the adult or winged insect. The injury is done wholly in the second of these stages,—the "flaxseed" being dormant, a stage of transformation merely from the maggot to the winged fly —and the latter being itself entirely harmless. [*See plate, p. 380.*]

There are always two destructive generations in a single year, and under some circumstances at least three. In fact, I have obtained evidence this spring from breeding cage and experimental work in the new

insectary of this office, that there may be even *four generations* which attack the wheat with destructive effect,—*two* in the spring and *two* in autumn. The *principal* injuries, however, are done by the *last autumnal* and the *first spring* generations.

The eggs are a slender oval, about a fiftieth of an inch in length, and small enough to lie lengthwise in the grooves upon the upper surface of the leaf of the wheat. Those for the principal autumn brood of the maggots are laid most commonly upon the leaf of the young wheat. The maggot hatching from these makes its way down the leaf to the base of its sheath near the root, and here this milk-white, oval, smooth larva remains almost motionless, until it gets its growth—commonly in November—after which it forms a tough, smooth, dark brown case, within which it spends the winter, still in the same position. From this case (the "flaxseed" above mentioned) the winged insect bursts forth about the first of the following April, in the form of a delicate, nearly black, two-winged fly or gnat, which has a very close resemblance to a small mosquito. The sexes pair at once, and the eggs for another generation are laid almost immediately in the field, the adults perishing soon thereafter.

The maggots hatching from these spring eggs go through the same course of development, at the base of the stalk, behind the sheath of the leaf, and do the principal part of the damage noticed in the spring, causing the well-known "crinkling" or falling down of the straw as the wheat heads out. Many of the winged flies of this brood hatch some time before harvest, beginning to appear, in fact, by the end of May, and these lay eggs at once and give rise to a *second spring* brood,—a fact clearly established this season by breeding experiments at Champaign. By harvest practically all are in the so-called flaxseed state, and the greater part of them remain behind in this condition in the stubble after the grain is cut. A few, however, are carried away with the straw. From these harvest-time flaxseeds the fall generations descend, the first of them appearing either in the volunteer grain or in early sown wheat, and the second—the hibernating generation already referred to—in wheat of the regular crop. The laying of the eggs for the first of these generations certainly begins by September 1st, and apparently somewhat earlier. The average length of life of one generation or brood (except the hibernating one), from any stage around to the same stage again, is about six weeks.

It is, however, a fact of considerable economic interest that this division into generations is not anywhere complete, but that flaxseeds of any generation may lie dormant during the whole life of a generation following, finally hatching with the descendents of their original contemporaries. Thus, of those flaxseeds which form in May and June, some may give the winged fly in June and July and others not until September; and some of those which form in volunteer wheat in September, may hibernate and emerge the following spring.

My experiments made to test the possibility that the Hessian fly will breed in wild and meadow grasses have thus far yielded negative results.

This life history, complicated as it is, will repay careful study by every wheat farmer, for on it must be based all practical measures for the prevention of injury to the wheat. [*See illustration, p. 380.*]

The most important general preventive and remedial measures are the following:

1. As a large percentage of the insects remains in the stubble at harvest, in the flaxseed state, and as the flies which hatch from them later are weak and delicate, the ground may well be plowed as soon after harvest as practicable, and rolled to close the cracks through which the winged insects might escape. If the stubble can be made to burn, this will, of course, destroy the flaxseeds even more effectually.

2. The volunteer grain springing up in the fields must be closely watched, and measures taken to destroy it about four weeks after its appearance, as it will otherwise assist to carry the insect through the summer in undiminished or perhaps larger numbers. The most convenient method of doing this will depend so much upon the season and the cropping planned, that each must select his method for himself.

3. Such of the flaxseeds as are carried away in the grain may be destroyed by heating or burning the screenings from the thresher, if the wheat is threshed at once.

4. To prevent the wheat from becoming infested in fall by the first autumnal brood, and to escape as much of the second as possible, the sowing of the wheat may, with advantage, be postponed as late as is consistent with its reasonable safety from winter-killing—to the last of September or the first of October, according to the common practice in the southern half of Illinois.

5. The damage done by any but the severest kind of an attack will depend, other things being equal, on the fertility of the soil and the strength of the plant. If the latter be strong enough to send out from the root new and vigorous stalks to replace those killed by the maggots of the fly, a considerable amount of fly attack may be scarcely noticeable at harvest time. From this it follows that the maintenance of the fertility of the soil is often a measurable safeguard against loss. I have no doubt that the soluble commercial fertilizers applied in spring to infested fields would have a happy effect, whether with profit or not can only be tested by experiment.

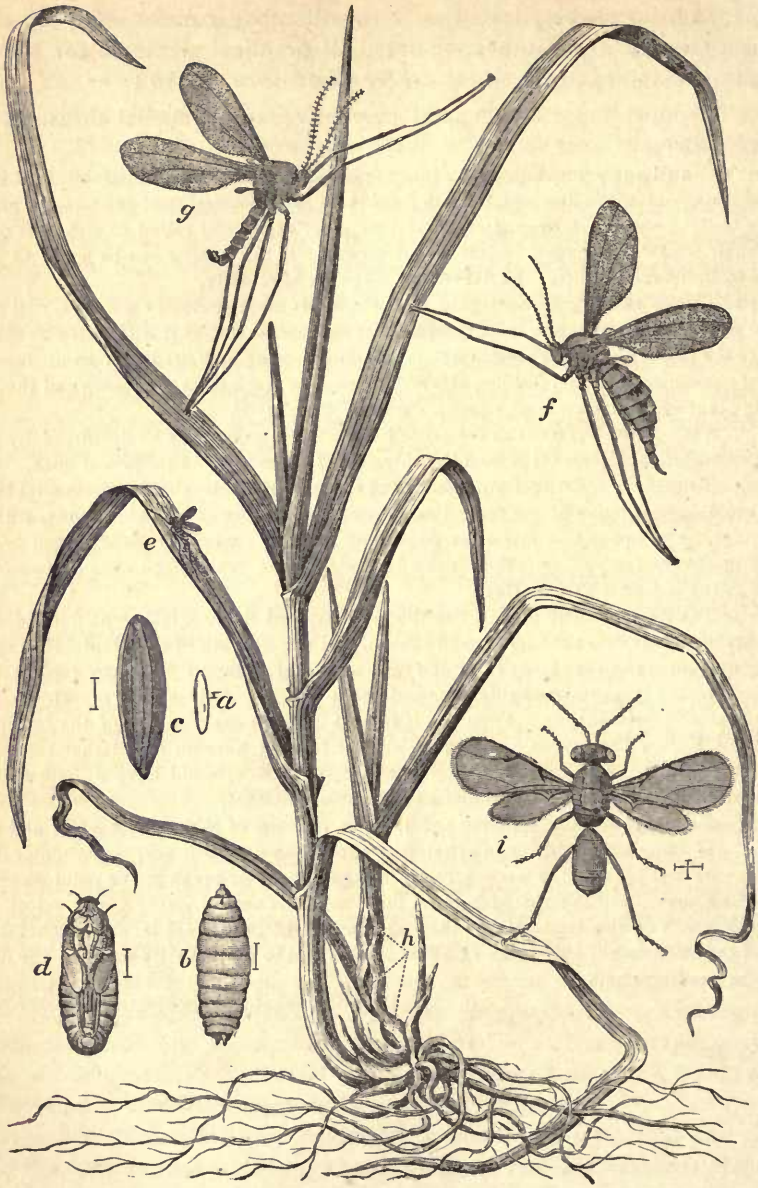
6. Finally, other things being equal, those varieties of wheat with a stiff and flinty stem, and those which tiller somewhat freely from the root, will suffer least under fly attack—the first because the straw will not so readily bend or break at the point weakened by the maggot; and the second because the flies of the second spring brood select fresh young shoots for the deposition of their eggs in preference to the older and tougher stalks, with the effect to kill only these valueless sprouts and to diminish by so much the injury to the heading stems.

S. A. FORBES, Ph. D., *Consulting Entomologist.*

CANADA THISTLES, THEIR EXTERMINATION.

Experiment No. 92.

The so-called Canada thistles are, in certain great areas of our country, justly considered the worst weed-pests of tillable land. (Notwithstanding the popular name, the plant is of European origin and was early introduced throughout our eastern seaboards and thence more or less scattered westward.) Among all bad weeds they are pre-eminently bad



Explanation of Plate. The Hessian fly and its transformations. A healthy stalk of wheat on the left, the one on the right dwarfed and the lower leaves beginning to wither and turn yellow; the stem swollen at three places near the ground, where the flaxseeds (*h*) are situated, between the stem and sheathing base of the leaf.

a, egg of the Hessian fly (greatly enlarged, as are all the figures except *e* and *h*); *b*, the maggot, enlarged, the line by the side, in this and other figures, showing the natural length; *c*, the flaxseed, puparium, or pupa case; *d*, the pupa or chrysalis; *e*, the Hessian fly, natural size, laying its eggs in the creases of the leaf; *f*, female Hessian fly much enlarged; *g*, male Hessian fly; *h*, flaxseed between the leaves and stalk; *i*, parasite of the Hessian fly, male, enlarged.

Their facility of distribution by seeds, their perennial multiplication by root-stocks, their great tenacity of life, their rank growth, and their defensive, sharp-pointed spines cause them to be dreaded by the farmer and avoided by his flocks and herds. It is not strange therefore, that in the Mississippi valley several of the state legislatures have enacted special laws intended to prevent the introduction of this well recognized pest and to exterminate it where it has obtained a foot-hold. In Illinois such enactments have been in force since February 28, 1867, and the present law dates from March 15, 1872. Any board of town auditors, or commissioners in counties not under township organization, any city council, or trustees of villages, may appoint a "Commissioner of Canada thistles," who, when appointed, is clothed with proper authority and required to attend to the thorough eradication of every plant of this noxious weed. Prosecutions may be made and fines imposed upon anyone neglecting the requirements of, or refusing to obey, the law. The only other weed against which the laws of our state are directed is that known as the cocklebur—act in force July 1, 1879, and applying only to highways.

But no law, in and of itself, can extirpate Canada thistles, and the provisions of the Illinois statute have been much too often neglected. There exist to-day, within the borders of our state, numerous patches of these thistles—centers from which, in the ordinary course of distribution, larger areas must become infected. It is high time that the battle of extermination should be earnestly begun and persistently continued until not a plant is left to perpetuate its kind. This is entirely feasible as the account hereafter given shows. Whatever may be thought of the reproductive and recuperative powers of these noxious plants, they can be beaten at no great cost if the warfare is begun early enough, though each year's delay must make the expenditure greater. But even after the total annihilation of the plant we should still have to be alert, however, to prevent its regaining a foothold with us, because it is very liable to be reintroduced, especially in the packing used in shipping heavy goods, like iron castings and marble, from the New England states and Canada. Most of the plants now found in Illinois are from seed originally brought in this way. But if attended to at once any such new starts would be easily subdued.

Having thus recognized Canada thistles as exceedingly bad weeds in Illinois and, as such, appropriately condemned by special laws, it must be said further that throughout most of our area the plant is by no means so obnoxious as it is in poorer and more clayey soils further north and east. A very striking pecularity in the development of the plant in Illinois, and the adjoining regions, is that it rarely produces seed. Nowhere is the weed more vigorous in its growth and nowhere does it spread more rapidly through the soil by its subterranean root-stocks, and nowhere are flowers more abundantly formed; but for some unknown reason, seed, capable of germinating, is almost never developed in Ohio, Indiana, and Illinois, except in certain restricted areas. This is probably true of other

parts of the Mississippi valley, though the writer has no direct knowledge upon the subject beyond the boundaries named. On the bluffs bordering Lake Michigan, in Illinois, seed is not rare in the heads of the great numbers of plants there everywhere found. But this does not change the general statement just made. By a careful examination of hundreds of these heads grown in the central part of Illinois, and from scores of different patches of the plant, not a single sound seed has been found. It is much to be regretted that the cause of this peculiarity cannot be now given. No doubt there is a reasonable explanation, and no doubt sufficient further investigation would reveal the cause of the observed unfruitfulness. In the localities where the plant does produce seed in abunnance, there are two easily recognized forms of the thistle. One plant has a shorter stem, more condensed foliage, with smaller and more numerous leaf lobes, and a decidedly shorter head or flower cluster than the other. There is also a different shade of green in the foliage, which is easily recognized, when the plants are side by side, in a good light. As the flower heads mature an examination reveals the fact that the shorter ones never produce seed capable of germination, though the rudiment of the fruit is present. In these heads the pappus or downy growth fitted for carrying the seed through the air, has comparatively little development, while it is abundant in the heads of the other form. If now we examine more closely we shall find that the florets of the shorter heads produce an abundance of pollen, while in those of the longer heads the stamens are rudimentary, or at least bear little or no pollen. The pappus of the latter attains double the length of that of the shorter heads, and admirably serves the purpose of widely distributing the abundantly produced seed. We see, therefore, that the plants are essentially male and female, or staminate and pistillate as the botanists call them, though in both all the parts of a perfect flower exist structurally. All the stems springing from the same root are alike in this respect, so that it is common to find each form in separate patches of greater or less extent. Numerous insects visit the flowers and carry the adhesive pollen from patch to patch. Possibly some pollen is thus carried by the wind, though it is better fitted for the former method of distribution.

The seeds maturing in July and August, germinate at once, under suitable conditions and the hardy little plantlets survive the winter, ready for the first opportunity in the spring to push into vigorous growth, though no doubt much of the seed lies unsprouted in the ground during the winter.

This species differs from all other thistles in our country, in the possession of underground stems, called root-stocks. These are white, flexible, often greatly elongated growths, sufficiently different from the true roots to be readily recognized by any one. These root-stocks, unlike roots, are abundantly furnished with buds, from which the new, air-growing stems may arise. They usually grow horizontally in the soil, at depths varying from a few inches to from one to two feet. Separation

from the mother plant does not kill them, because in the normal condition of things they are abundantly supplied with stored nutriment quite sufficient to enable the young, upward-rising stems to reach the surface and develop their first green leaves. Then these new leaves furnish a further supply to the subterranean root-stock, and its continued growth is rendered possible. It is in this way that a single plant of Canada thistle may give origin to an acre's dense growth in a few years without the production of a single seed. In the winter this subterranean part of the plants is not killed, hence the early and abundant development of the aerial portion in the succeeding spring and summer.

This plant has few natural enemies, but it does not altogether escape. Certain parasitic fungi blister and corrode its spine-bearing leaves. Among these *Puccinia suaveolens*, a rust like that of wheat, sometimes aids considerably in checking the growth and reproduction of the thistles. A little fly renders still better service, in destroying the seeds where these mature. In August, 1889, the writer collected heads of this thistle in Ontario, Canada, and put some of them into a box where they remained until November, 1890. At the latter date the box was opened and there were found good specimens of this pretty fly, which Mr. John Marten kindly identified as *Trypeta florescentiae*, described in Loew's Monographs of the Diptera of North America, Part III., p. 254. In this place it is said the larvæ inhabit the flower heads of different species of thistles in Canada and all Europe. I do not know that the fly has been observed in Illinois, though several other insects help in destroying the seeds of other thistles.

The most important question in this matter, and the special one for which this report is made, is how may Canada thistles be exterminated in the surest manner and with the least expense. As at least a partial answer to this question the following account is submitted:

Information having been received of the existence of a patch of Canada thistles near Mattoon, Ill., on the farm of Mr. Wm. Burgess, and having the promise of the proprietor to furnish the necessary labor, this Experiment Station undertook the direction of their extermination. Upon a personal inspection it was found that the patch consisted of about two and one-half acres in the corner of a field recently purchased by Mr. Burgess. The land was originally prairie and the soil continues to be rich and black. The surface is generally, in this region, very level but the thistles occupied the crest of a slight elevation. Some of the neighbors knew that they had existed in this spot during at least eight years, but no further history of the patch could be obtained. No others were known in the neighborhood though some had grown in certain streets of the town less than two miles away. That these thistles in the farm patch had not spread by seed was evident, because in that case they would have been far more widely dispersed over the adjoining fields in which there existed no greater obstacles to their growth than were present in this special corner. During the last year it has been observed that the plants had spread upon the borders of the patch two or three rods into previously

unoccupied ground, and this in spite of the cultivation and growth of a crop of corn. When the field was visited June 22, 1889, the thistles were found to be about two feet high,budded for bloom, and so thick upon the ground that it seemed impossible for any more to gain standing room. Unless one wore leather leggins it was painful business to walk through them, and horses refused to be driven through for the same reason. Upon digging down in the earth the soil was found to be plentifully supplied with the horizontal root-stocks, the lowest of which were nearly two feet from the surface,—most adundant however about one foot deep. After surveying the special conditions of the place three experiments were determined upon as set forth in the letter of instructions, written after the examiner returned home, and from which the following extract is made:

1. Cut the thistles as close to the ground as possible with scythe or otherwise when in full bloom. It is supposed that this work will be required during the first week in July.

2. Divide the land in three equal strips running north and south. Plow strip No. 1 as soon as practicable after cutting. Then harrow well to bring the roots to the surface. Sow millet or Hungarian grass seed at once, so as to make a heavy crop. The plowing in no place to be more than four inches deep. It is expected that this crop with that of the thistles that will grow will be plowed under later in the season when rye is to be sown, to be similarly turned under next spring.

On the second strip, after the first mowing, leave the land until the thistles sprout anew, about 10 days, then plow say four inches deep and harrow. Leave this land without crop of any kind this year; but with some surface cultivator, which will effectually remove all of the new growth of thistles, go over the land as often during the season as the thistles make their appearance above the surface, or once in about two weeks. During the driest weather the interval may perhaps be longer.

On the third strip, soon after the thistles are cut, cover such part as may be practicable with straw, so that it will be six inches deep when well settled, taking care that it is evenly spread. On the rest of the strip spread a heavy coat of barn-yard manure at the rate of thirty good sized loads to the acre. After it is thoroughly spread plow the land as in the first and second strips, and cultivate in same manner as the second strip.

3. In all this work ultimate success will depend upon the thoroughness with which the attempt at eradication is made, and it will be desirable to have these directions closely followed.

October 8, 1889, Mr. W. C. Lane, who rented the farm and to whom was entrusted the execution of the plans for extermination, reported that the whole patch had been mowed July 17th, when the plants were in full bloom with some of the first flowers becoming dry. Wet weather followed and further operations were somewhat delayed, but July 31st and August 1st lots 1 and 2 were plowed and harrowed and the next day lot 2 was sowed with millet at the rate of one bushel to the acre. Lot 3 was now manured as directed and plowed and harrowed, but the straw was not applied. At the time of the plowing numerous sprouts had started from the old stocks. Rain occurred and the millet made a good start. August 20th, fresh plants about 2 inches high were abundant and lots 1 and 3 were thoroughly cut with a disk harrow, which in the rather mellow ground did good execution. September 10th the disk harrow was again tried, but this time on account of considerable rain the ground proved

too hard for the implement to destroy all the plants and a plow was substituted. At this time the thistles in the millet were very numerous and 4 to 5 inches high while the millet itself was about one foot high. The whole was turned under. At the date of the report (October 8th) the whole had just been replowed and seeded with 1½ bushels per acre of rye. Preceding this plowing it was observed that the thistles on the part having millet were not half so thick as on the other portions, but no decided difference was observed on the manured plot. The total expense to date was $13.75. This included wages for a man at $1.25 per day and a man and team at $2.50 per day.

From April 15 to 25, 1890, the rye, which had made a good stand, was plowed under and the ground thoroughly harrowed. Some thistles of weak growth had appeared in the rye before this plowing and scattering ones came up afterward, but very different in vigor from those of the preceding year. A second and third plowing followed May 25th and June 25th. A visit was made to the place on the first of these dates, while the team was at work, and a close examination was made for living thistles which were found to be few in number and widely scattered. There were still great numbers of subterranean portions of the plants turned up by the plow, but except in very rare instances these were dead and beginning to decay. A plat one rod wide and ten rods long was measured off, upon which a year before thousands of distinct thistles were luxuriantly growing, and an exhaustive search was made for living plants then showing above ground. It will be remembered that this was two months subsequent to the last plowing during which time the thistles had an excellent chance to grow, as far as external conditions were concerned. Twenty-six such plants were found, all small and of feeble growth. At the time of the third plowing in June, there were reported still fewer plants. July 14th, no thistles having again appeared, all but half an acre of the area was sowed with about one bushel of millet seed per acre. At this time the ground was quite dry and little rain fell during several succeeding weeks. The millet made a comparatively poor growth, yet not a single thistle could be found in this part of the field at any time during the season. The millet was cut for hay September 15th. The half acre not seeded with millet was worked with the disk harrow August 20th, after which nothing was done except to search from time to time for thistles of which up to the time of the report (October 8th) 45 plants had been found. These were commonly found in little clusters, 2 to 4 together, springing from the same subterranean source.

From the above it may be assumed that the job is practically completed, though careful cultivation should be given some crop on the ground next year, and the closest possible watch kept during the season for the last straggling representatives of their wonderfully vigorous predecessors. It will be observed that the original directions were not fully followed. This resulted from the fact that the man who did the work was so thoroughly occupied by other duties on the farm, that could not give

this experiment more time. It seems, however, that little difference could be observed the second year on account of the difference in treatment of parts of the field the first year. That upon which the first millet grew probably had the fewest thistles during the early part of the second year, but we have no exact data. The manure was applied with the hope of so stimulating the growth of the plants that the shock of disturbance with plow or otherwise would have more effect. It is regretted that we have here nothing positive from the results, or rather that the observations were not critically enough made to make known such diferences as probably existed.

The expenses for the second year amounted to $17.50 with a credit for hay (millet) of about $5.00, or a net cost of $12.50. Adding that of the previous year we have for the total expense $26.25, or $10.50 per acre. That amount would have been less had the entire plat been treated in the same manner during the first year; for, of necessity, time was lost in changing from one thing to another in managing the small areas. It ought to be said that during the second year a strip twenty-five feet wide around the patch, outside of the outermost thistles, was treated the same as the infested area, to make assurance doubly sure.

From the experience obtained, and from other information, we may formulate the best method of exterminating these pests when in full possession of tillable ground as follows:

1. Cut the thistles when in full bloom [July] as close to the ground as possible.
2. Plow about three inches deep and sow millet or Hungarian grass, seeding heavily, harrow. This may follow the preceding at once or after some two weeks' delay.
3. In September plow under the crop, or save it for hay, as desired. At all events plow and seed liberally with rye.
4. Plow under the rye in May and seed again with millet, or Hungarian grass, or plant to some hoed crop [corn] and give the most thorough cultivation, with continued searching for, and destruction of, every remaining thistle.
5. Continue the clean cultivation and sharp lookout for thistles another year.

On poor land labor would no doubt be saved by manuring, beginning preferably in the early spring of the first year, or better still, the preceding autumn or winter. The cultivation need not be deep at any time. Cutting the thistle stems three inches below the surface is as effective as at any greater depth, and labor is saved. But the utmost endeavor should be made to include in each process every living plant. From repeatedly cutting off the aerial parts, the underground portions are sure to die of exhaustion, and mostly within the limits of one summer.

I have now to report the results of an experiment in exterminating this pest from a small area in blue-grass sod. This infested spot, about eight square rods in area, was on the campus of the University, in an out of the way place not kept in order with the lawn mower. The soil in this particular locality is not very fertile, and the grass makes a poor growth compared with the usual luxuriance on these grounds.

The process adopted in this case consisted simply in cutting off the plants at or just beneath the surface of the ground with a hoe. Begin-

ning June 17, 1889, this was carefully done once each week until September 23d, of the same year. No record was at first kept of the number of plants thus cut, but from August 5th the count was made and is reported as follows:

August	5 ... 98	September	2....74
"	12....107	"	9 ...78
"	19.... 80	"	16....62
"	26.... 84	"	26....26

The plants were conspicuously smaller towards the close of the season and it is quite possible that some escaped at times because small and hidden in the grass.

During the summer of 1890 the spot was similarly examined and treated the first of each month (once a month only) from May to November. The number of thistles found and cut off each time were in order as follows: 1, 1, 3, 1, 0, 1, 0.

This, too, practically closes the experiment, though some attention will doubtless be demanded next year. The time consumed in each examination was from one to two hours,—necessarily longer on account of the care required to find the plants among the grass. Counting the workman's wages at $1.25 per day, the total cost is about $4.00, or fifty cents per square rod.

From the foregoing it may be inferred that Canada thistles in Illinois can be practically exterminated within one or two years. The former time is sufficient, if every plant is frequently enough cut off at or just beneath the surface of the ground. On arable land only one year's crop need be lost, though practicing the greatest possible economy of labor. The total necessary expense of eradication is trifling compared with the rapidly increasing detrimental results of allowing the noxious plants to exist and multiply from year to year. In our part of the country to allow the thistles to grow is all the more inexcusable because the thistle produces no seed.

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All communications intended for the Station should be addressed, not to any person, but to the

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